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Genetic Risk Induced by Carbon-14 Generated by Nuclear Explosions

Dear Editors:

In an earlier paper by Linus Pauling titled "Genetic and Somatic Effects of Carbon-14" (*1*), it is established that this by-product of nuclear explosions might induce greater genetic and somatic damage than previously assumed. Furthermore, Pauling states that the damage produced by carbon-14 that is incorporated into genetic material is responsible for only 10% of the total genetic damage generated by carbon-14 in humans. Nevertheless, it is of interest to evaluate this hazard by means of a simple calculation.

If it is accepted that to date a total of some 540 megatons of carbon-14 has been released into the atmosphere by open nuclear explosions (*2*) (fortunately, nuclear experiments have changed in nature, and in the past few years most of these tests have been carried out underground), it can be assumed that about 1300 kg of carbon-14 would be delivered into the biosphere as a result of the reaction of neutrons with atmospheric nitrogen (if for every 30 megatons of power, approximately 223 kg of carbon-14 are generated and 74 of these are released into the atmosphere). On the other hand, if the total mass of carbon in the atmosphere plus that of the biosphere is approximately 2.5×10^{15} kg and if it is assumed that the carbon-14 generated by the explosions could mix homogeneously with the original carbon, as a result of its low rate of decay, the ratio 1300 kg carbon-14/2.5×10^{15} kg carbon-12 would give an idea of the balanced proportion of $^{14}C/^{12}C$ present in the atmosphere at a time.

For each mammalian cell there are approximately 10^9 to 10^{10} DNA base pairs (*3*) and about 10^{11} atoms of carbon (20 atoms of carbon per nucleotide pair). Then with time (shorter than the period of radioactivity half-life of carbon-14), one atom of radioactive carbon from the explosions would be incorporated into approximately 10 human cells. Because the decay constant, expressed in days, of carbon-14 is 3×10^{-7} and because for each carbon beta emission at the level of DNA molecule, a damage can be generated by the recoil of the carbon atom, we conclude that in the course of a day (approximate replication time of a human cell), one decay or mutation could be expected in every 3×10^7 to 3×10^8 cells. This probability should be compared with the natural rate of mutation of 10^8 to 10^{10}, keeping in mind the eventual low probability of repair of genetic damage spreading to both DNA strands.

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